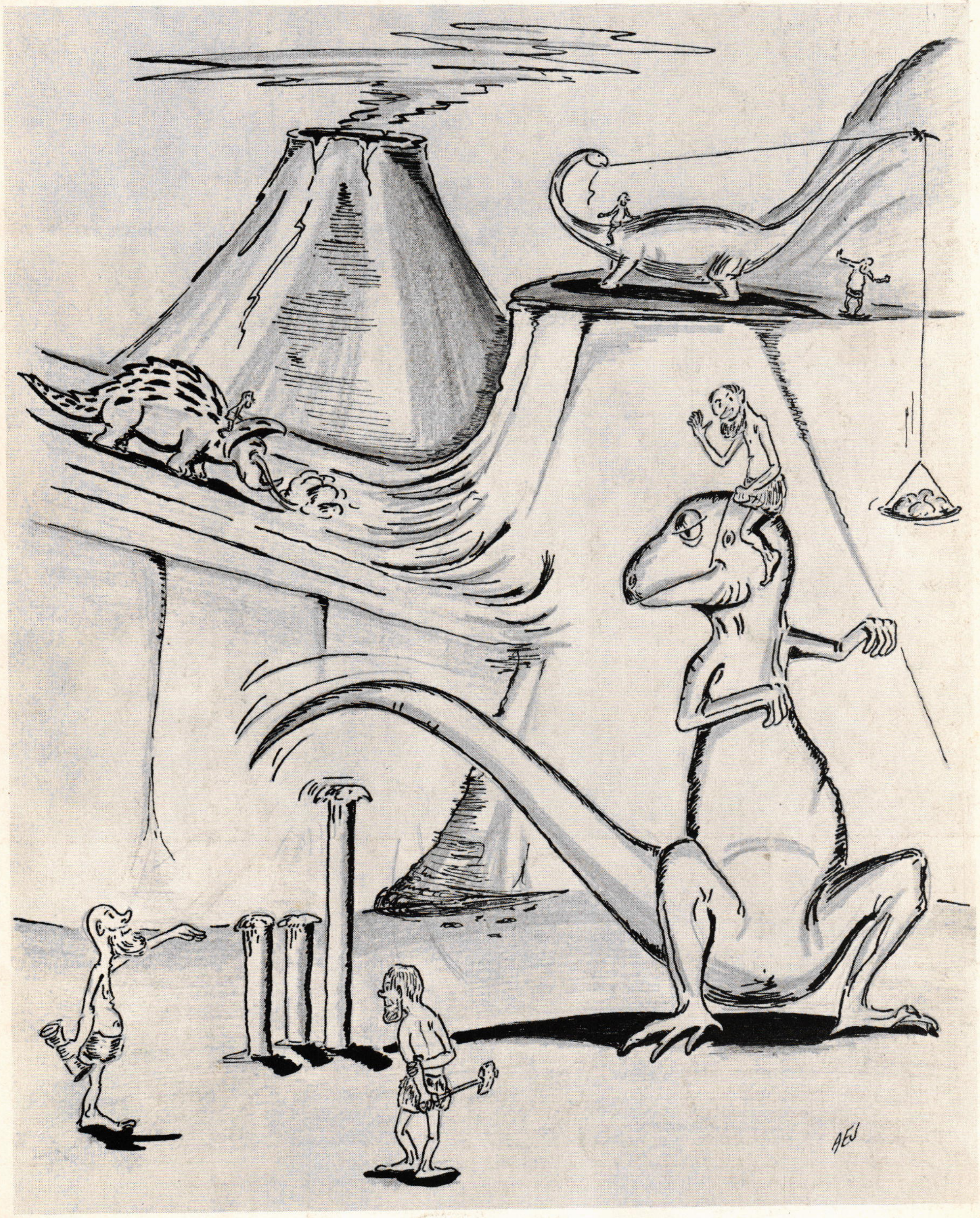
the Mechelecciv

VOL. 19 APRIL 1961 NO. 5

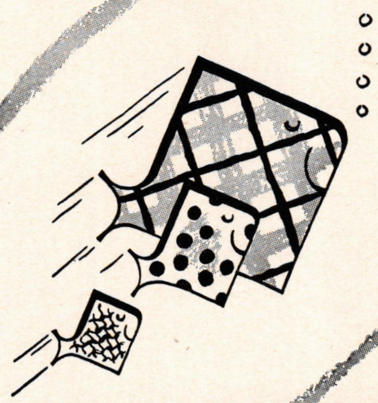
THE GEORGE WASHINGTON UNIVERSITY ~ SCHOOL OF ENGINEERING ~



THE GEORGE WASHINGTON UNIVERSITY

APRIL 1961

there's room to GO and GROW–



. . . at SIKORSKY AIRCRAFT

A *"stream-of-action"* environment with unusual growth possibilities should be a major factor in a choice of career. And that's an excellent reason for considering carefully the opportunities existing in Sikorsky Aircraft.

We believe that our company is just the *"right-sized stream"*. Young engineers can enjoy diversified, small-group activities, as well as stature opportunities in a field that is wide open to the expression of imagination and professional competence.

Sikorsky Aircraft is the company which *pioneered* the modern helicopter. Our current program is far-ranging and is recognized as one of the broadest and most challenging in the entire aircraft industry.

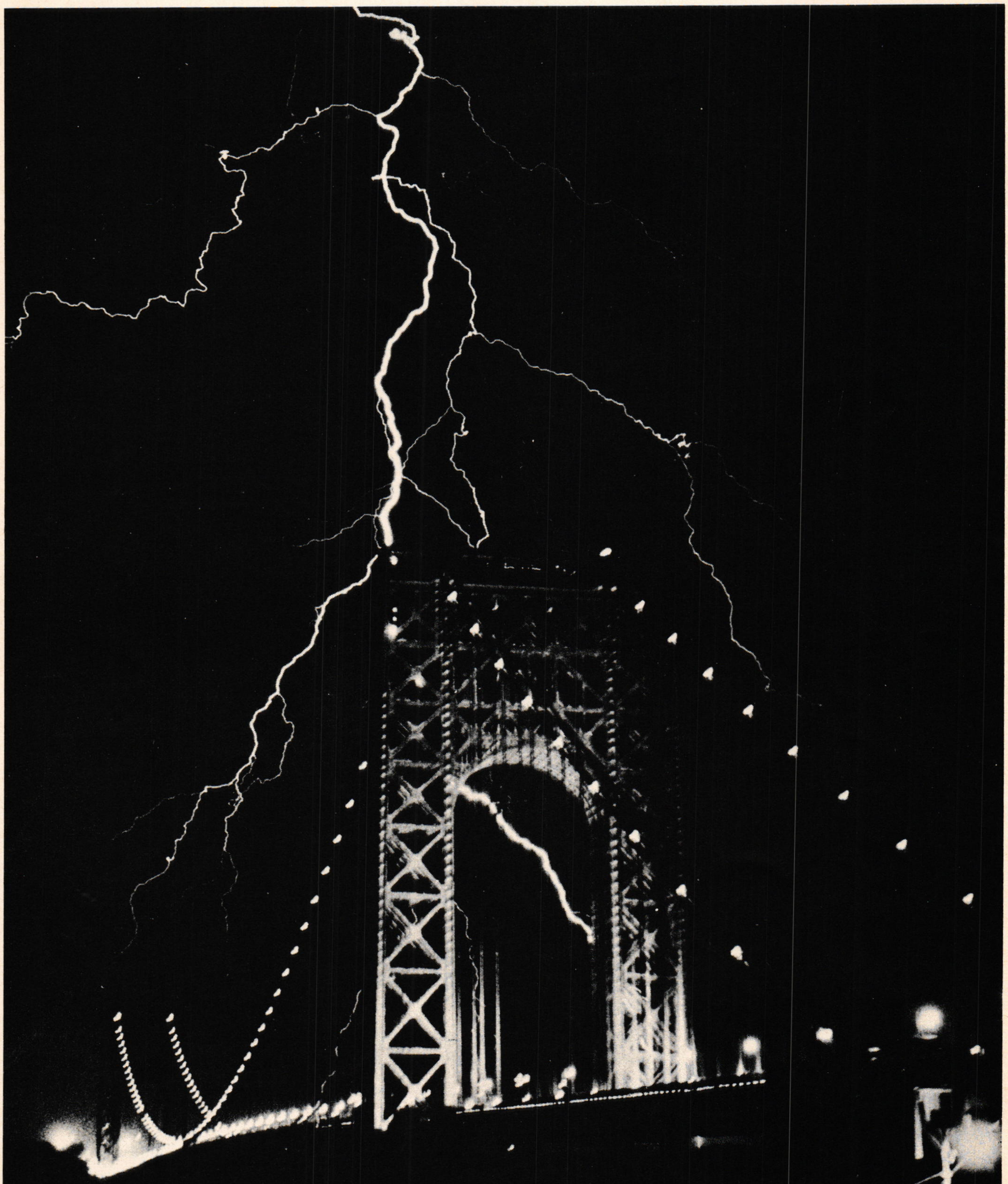
Work associations are stimulating and in an atmosphere of progress. Assignments could include joining an *electronic* team of twenty to thirty associates—or—working with a highly selective group of four or five on interesting problems of *radiation, instrumentation, auto pilotage, automatic stabilization,* etc.

If you want to enter this *"stream-of-action"*, the time is *now*. Opportunities for personal progress have never been greater.

For detailed information about careers with us, please write to Mr. James L. Purfield, Employment Supervisor.

SIKORSKY AIRCRAFT STRATFORD CONNECTICUT

DIVISION OF UNITED AIRCRAFT CORPORATION



Pictured above is a lightning stroke over the George Washington Bridge.

the Mecheleciv

VOL. 19 APRIL 1961 NO. 5

ARTICLES

DEPARTMENTS

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Entered as second class matter March 6, 1951, at the Post Office at Washington, D. C., under the act of March 3, 1879. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C. or telephone FEderal 8-0250, Extension 528.

Subscription Price: Two Dollars

CHANGE OF ADDRESS: Send your new address at least 30 days before the date of the issue with which it is to take effect.

THE PRICE WE PAY

How will the recent tuition increase affect you? Will you accelerate or decelerate your educational period? Will you be rewarded or penalized? Are you a part-time or a full-time student? The amount of tuition you will pay next year will depend on how you answer these questions. Heretofore the distinction between a full-time and a part-time student was a nine semester hour division more or less. There has recently been derived an entirely new connotation for the distinction. A full-time student taking up to 20 semester hours can continue to pay as little as $25.00 per hour. Or, he can pay $500 for the first 15 hours and take any additional courses at no more cost. A part-time student however taking something less than 15 hours has just had his tuition increased from $25 to $35 per hour.

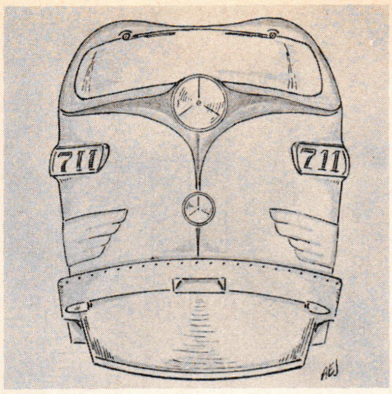
There can be two justifications for an increase in tuition. First, the student will realize that the price is competitive. Secondly, a large part of the increased income will be applied to competitive bidding to keep and to get salaried faculty. Whether the variable tuition scale is unique to this school, or a pattern that, over the long term, has been proven in another school is of no concern to us. We can neither change it or reduce its impact.

Without laboring the immediate effects of the tuition increase further let's consider some future aspects of progress.

Let us hope that progress here will have many faces. Equally important with increasing tuition should be the development of a professional atmosphere within the engineering school. The students as well as faculty and administration have a responsibility to accomplish this end. The initiative we take to meet this responsibility should be immediate and emphatic.

Why should we concern ourselves with a dynamic curriculum and competitive prices and continue to admit that the engineering student does not command the same respect and prestige as the medical and law student?

We would hope that someday by the culmination of all these efforts that the engineering student will, by his professional appearance and conduct, be recognized as a member of an autonomous professional institution. Perhaps there are areas of improvement beginning within the educational institution that could settle once for all the classic question. "Are we or are we not professional people?"



"Look Ahead: Look South"

by Charles R. Gartrell

Since the end of World War II, expansion and diversification of both agriculture and industry, long underway in the states of the old Confederacy, have continued at a record-breaking pace. Every year new factories by the hundreds add their output to the South's rising tide of industrial production. Per capita income is skyrocketing, and the region is enjoying a prosperity such as it has never known before. At one time a so-called weak spot in the American economy, the South is now truly a land of opportunity.

Typifying this dynamic New South is the 8000-mile Southern Railway System, largest common carrier in the region. Its rails reach into every state south of the Potomac and Ohio Rivers and east of the Mississippi, except West Virginia.

The Southern has contributed much to the miraculous growth of the young industrial Southland it serves. And, keeping pace with that growth, it has progressively modernized its own far flung plant and operations through an all-inclusive program of improvements that has given new significance to its famous slogan, "The Southern Serves the South." Since 1945, the Southern has spent about $500-million on new and better rolling equipment, and on improvements of the road. The first railroad system to become dieselized, Southern has acquired millions of dollars worth of locomotives and new cars; track standards have been improved, and Centralized Traffic Control has been installed. Right now it probably has more new and modernized classification yards than any other railroad. Train radio has been installed on a large scale. Today's Southern is a new railroad just as truly as the territory it serves is a New South.

Southern has now emerged as the pace-setter of forward trends in railway engineering and transportation. The energetic modernization of the System was put forth not with mere words, but by actual ground-root changes in the physical character of the road. Southern's new frontiers on the railway horizon mean a new and higher standard of service at less cost.

Any good profile of Southern Railway rightfully portrays the carrier as recognized leader in modern railway transportation engineering. But, more than that, Southern's success story will tell of a railroad's dedication, determination, and hard work to produce a truly modern railroad today -- with the engineering dreams of tomorrow. Let's take a ride on the Southern and see some of these creative dreams! Let's follow the Southern and its promise of excitement and high adventure along the iron road!

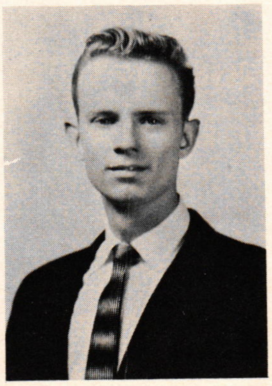
In the old days of railroading, when trains chugged out of the station they were not heard of again until they passed or pulled into the next station. Nobody really knew for sure where the trains were. Nobody knew exactly whether the trains were keeping up their speed, running ahead of schedule, lagging behind, following too close, stalled -- or even derailed on some desolate section of road. But those were the old days.

Today a modern railroad can keep track of its trains, know exactly where they are at all times, and predict with precision the points where trains will meet or overtake one another. This information enables more intelligent routing of trains and hastens the flow of traiffic.

How does the Southern keep track of trains? With CTC! The modern train control device on the Southern is the company's expanding network of Centralized Traffic Control. Briefly explained, Centralized Traffic Control -- or CTC -- means the effective control of operations over a large mileage of railroad from a central point. This control is achieved most effectively by use of extensive electronic equipment not quite like anything used before modernization. Even the tracks are different with CTC!

The physical railroad under Centralized Traffic Control might well consist of a stretch of single track perhaps 10 miles long, followed by a stretch of double track probably 5 to 10 miles long. This sequence repeats itself over a given distance of as much as 350 miles -- allowing extreme flexibility of train movement. In many cases, CTC may operate over extended double track territory, with the added advantage of having two tracks available for either "north" or "south" movement -- or for both simultaneously -- restricted only by the speed of the different trains and their respective distances apart. Specific lengths of single track and double track segments

--Continued on next page



A native of the Nation's Capital, Charles R. Gartrell is a night student in the School of Engineering—working toward the degree of Bachelor of Civil Engineering, with major in mathematics. Qualified to write about the Railway by virtue of his 4 years' employment in the office of Southern's Chief Engineer, Mr. Gartrell is probably the only George Washington University engineering student able to view daily the technical progress going on within one of America's most efficient transportation systems. Prior to his association with the Railway, he worked for a time in the statistical division of Aeronautical Radio, Inc. (the "communications system" for the airlines). School activities include membership in ASCE; in addition, Charles' interests embrace tutoring of mathematics, physics, and Spanish. He and his wife Pat, live in Foggy Bottom near the GWU campus.

may vary and are dictated primarily by the geographical locations of industries and towns served by the Railway.

Control panel of the Centralized Traffic Control (CTC) installation governing the movement of Southern Railway trains between Atlanta, Georgia, and Greenville, South Carolina, adding safety and speed to train operation.

Along the right-of-way numerous electronically-controlled signals and power-operated switches further speed and safeguard Southern trains. Complementing the familiar semaphores and block-signals are electronic devices which, when actuated, will automatically apply brakes to a train -- should the operator of a train for some reason fail to heed a "red board" or other stop signal. To maintain constant verbal contact with trains (and within a train), Southern has equipped engines and cabooses with two-way radio sets for front-end, rear-end, and wayside communication. Let's follow a train through a section of CTC!

When a long freight train comes on the railroad at Atlanta, for example, a white light shows up on an electronic panel in the control center in Greenville. The panel is set up to correspond schematically with the layout of the actual road. As a train moves along the line of road, the white light moves along the panel. The dispatcher sees these lights moving and knows where the trains are at all times. By turning a dial on the panel, he can set switches and signals of this 150 miles of railroad. Meeting points can be arranged, and one train can be run around another without stopping, while both are moving in the same direction, even though one or two other trains may be approaching on both tracks farther down the line!

Centralized Traffic Control is just one more engineering inovation to guarantee Southern Railway's leadership in transportation service, technology, train safety, and speed of operations. Not only does CTC greatly increase the capacity of double tracks, but also is the safest, most efficient, and economical kind of operation.

The Southern recently received delivery of 48 2400-horsepower diesel freight locomotives. The latest design in motive power, they were developed to provide the utmost in diesel locomotive performance. Total cost of these new diesels represents an investment of almost $7-million. One look at Southern's brawny, rugged diesels is assurance enough that the Railway has one of the most up-to-date fleets of motive power in the country.

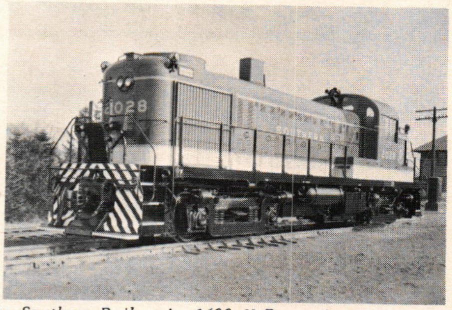
But modern motive power is a tradition on the Southern. As far back as 1939, Southern Railway engineers were contemplating the retirement of steam-engine facilities; in August of that year, the Company placed in service its first diesel yard switcher, Number 8560, capable of a then unprecedented 750-horsepower. However, Southern dealt the first deadly punch to the traditional steam locomotive when on April 29, 1941, the Company placed in service the world's first road freight diesel, E. M. D. #6100, rated at 1350-horsepower. From that time forward, the efficiency and speed of the powerful, sleek, streamlined diesel rapidly replaced the faithful old iron horse . . . until finally, in June, 1953, the change-over was accomplished. Southern Railway had taken a great stride forward in becoming the first major railroad system to claim complete dieselization. The use of diesel motive power has been an important factor in enabling this common carrier to conduct its operations efficiently and economically.

Southern's fine diesel power is complemented by some 54,677 freight and passenger cars kept rolling night and day by a diversified staff of carefully-trained transportation engineers and technicians. A standard freight car is a big, heavy, and especially expensive piece of rolling stock, costing nearly $10,000 each, while some special freight equipment may cost in the range of $22,000 each. Interested in reducing costs connected with the maintenance and replacement of these freight cars, Southern's management called upon its engineers to find a better, more serviceable freight car: to be of lighter weight, greater economy, and to require less maintenance -- yet to have a larger volume-capacity and possess greater strength and smoother riding characteristics than conventional cars.

The men of the carrier's mechanical engineering staff set out to find such a car. Following careful study came the result. Southern Railway freight cars of composite aluminum-steel construction, some 1,205 of them to date.

Entirely new in concept, these are high volume-capacity (up to 100-ton), roller-bearing gondola and covered hopper cars. Although initially more costly than conventional cars of the same type, this purchase represents the fruits of a pioneering step in adapting to freight car construction the lightness and corrosion resistance of aluminum.

Southern engineers have been busy at work developing new special-purpose freight cars and designing them to specific needs of the shipping public. For example, one Southern-designed and built car that is attracting widespread interest is the "EASY-LOAD - EASY-UNLOAD" freight boxcar. Available to shippers for a variety of commodity movements, its sides are doors -- which extend the entire length of the car -- and can be opened for quick loading from either side.



One of the Southern Railway's 1600 H.P. road switching diesel-electric locomotives, purchased in 1952.

--Continued on page 9

A Report on Tunnel Diode Amplifiers

by Ronald Sebol

Difficulty was encountered in finding accurate and comprehensive discussions of tunnel diode amplifiers, so the pertinent theory was derived and an operating amplifier was built and examined.

The current versus voltage characteristic of a tunnel diode is examined and it is shown how voltage gain is produced in some circuits. It is also shown that a tunnel diode can be represented by an equivalent circuit consisting of an inductance in series with a negative resistance which is shunted by a capacitance. The equivalent circuit is then analyzed in the complex frequency domain to show that for stable operation, the sum of the generator and load resistance of an amplifier must be less than the negative resistance of the tunnel diode and greater than $L_d\,G_d/C_d$.

A variable resistor, shunting the tunnel diode, can eliminate oscillations and allow the gain to be optimized.

Phasor diagrams facilitate working with tunnel diode amplifier circuits.

Tunnel diodes are able to operate as two terminal amplifiers with noise temperatures in the order of 200°K. This range of values is better than ten times lower than that which may be obtained from transistor amplifiers.[1] Furthermore, tunnel diodes are more resistant to the effects of temperature extremes and neutron radiation than transistors.[2] These considerations indicated that tunnel diodes could be profitably employed in a low-noise amplifier, capable of withstanding environmental conditions that would incapacitate a transistor amplifier.

The fact that amplification can be obtained in the negative conductance region of the diode characteristic can be shown quite clearly in a purely graphical manner. Figure 1 contains the necessary information.

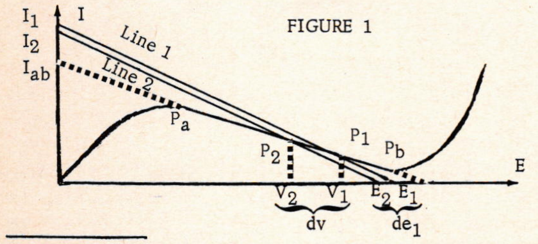


FIGURE 1

1. G.E. Research Laboratory, *Technical Information Sheet—Tunnel Diodes;* July 23, 1959
2. T.P. Sylvan and E. Gottlieb, *Electronic Equipment Engineering;* May, 1960

Line 1, with intercepts of I_1 and E_1, and line 2, with intercepts of I_2 and E_2, are the two load lines corresponding to input voltages of E_1 and E_2, respectively, and a fixed load resistance of R_1 ohms. $E_1 - E_2$ is a change of input voltage and $(V_2-V_1)-(E_2-E_1)$ is the corresponding voltage change across the load resistor, R_1. It may be seen from figure 1 that the change of voltage across the load resistor is greater than the change of input voltage, hence, amplification is in evidence. Also notice that the change of output voltage is opposite in sign to the change of input voltage. This effect would cause a sinusoidal signal to produce an output 180° out of phase with the input. In the region of the diode curve between P_a and P_b, the diode curve is sufficiently linear to warrant assigning it a slope of $-g_d$ or $-1/R_d$ mhos. This region is defined as the negative conductance region, and $-g_d$ and $-R_d$ are the incremental negative conductance and incremental negative resistance of the tunnel diode, respectively. As has been demonstrated, it is the negative resistance region in which amplification takes place. If R_1 is greater than R_d, the load line will intersect the diode characteristic in three points. The intersection in the negative conductance region will be in a state of unstable equilibrium, and continuous amplification will no longer be exhibited. As will be shown later, the instability described above is of an even more fundamental nature than the above-mentioned argument indicates.

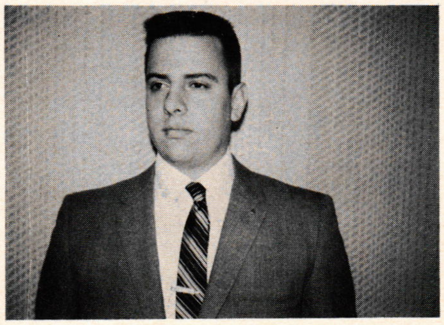
Why is the slope of the negative conductance region so often used to characterize the response of a tunnel diode? The linear approximation of the negative conductance region can be expressed mathematically as $I = -g_dV + I_{ab}$ (1) and the equation of an appropriate load line, such as line 1, is $I = -g_1V + I_1$ (2). Solving simultaneously, $-g_dV + I_{ab} = -g_1V + I_1$ (3), therefore, $V = I_1 - I_{ab}/g_1 - g_d$ (4).

Substitute E_1g_1 for I_1 and obtain the equation, $V = E_1g_1 - I_{ab}/g_1 - g_d$ (5). Differentiation with respect to E_1 yields $dV/dE_1 = g_1/g_1 - g_d$ (6). If the conductances are changed to resistances, expression (6) becomes $dV/dE_1 = -R_d/R_1 - R_d$ (7). dV is a change in diode voltage corresponding to a change of dE_1 in the input voltage. In the graphical analysis, $dE_1 = E_1 - E_2$ was such a change.

--Continued on next page

Ronald Sebold, a senior EE student, has spent the last two summers at the Diamond Ordnance Fuse Laboratory working in a telemetry circuits and systems design group. Several weeks of this time were spent developing a prototype RF amplifier employing tunnel diodes in a low noise I.F. amplifier. This paper is the result of work done during that time. Other work in which he was engaged includes designing part of the telemetry equipment for certain high altitude nuclear burst experiments.

Ron hopes to rejoin the group as a permanent employee upon graduating and to specialize in circuits and systems design.



Now consider the circuit in figure 2.

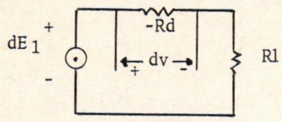


FIGURE 2

The voltage across the negative resistance is $dV = dE_1(-R_d)/R_1 - R_d$ (8). It is evident that equation (7) is identical to equation (8), so it follows that the response to a voltage, dE_1, which is superimposed upon some appropriate bias level, E_1, is specified by the response of a simple circuit in which $-R_d$ represents the tunnel diode. The only additional effects that need to be considered when using such an equivalent circuit for the diode are those due to ohmic resistance of semiconductor material not in the vicinity of the junction, lead inductance, and junction capacity. These effects modify the equivalent circuit of the diode in the manner shown by figure 3.

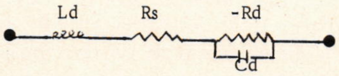


FIGURE 3

L_d and C_d are in the order of a few nano henries and pico farads, respectively, so they do not begin to affect the operation of the tunnel diode until high frequencies are considered. However, it is a serious error to assume that these quantities may be ignored when the stability of a circuit is being investigated.

The simplified equivalent circuit does yield some interesting results. Consider the amplifier circuit in which a generator V_{in} replaces dE, (see figure 2). $V_{out} = V_{in}R_1/R_g + R_1 - R_d$ (9). Notice that the gain of the amplifier, $R_1/R_g + R_1 - R_d$ (10) is negative due to the inequality $R_g + R_1 < |R_d|$, and that the gain is sensitive to changes in load resistance, generator resistance, and tunnel diode negative resistance. Also notice that the change of gain with respect to these parameters is high when the gain itself is high. If gain in the order of 20 to 30 DB is desired, it is necessary to include a variable resistor in the loop so that the gain of the amplifier can be properly adjusted. The variable resistor should be a low inductance type so that tuning effects and instability will not be introduced.

Now that the possibility of amplification has been examined, consider the total equivalent circuit in an amplifier configuration and see what requirements the circuit must satisfy if it is to be stable. The circuit under consideration appears in figure 4.

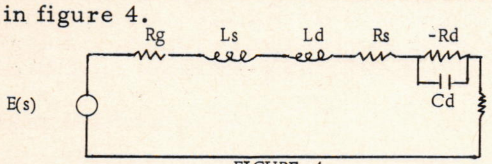


FIGURE 4

Let $R_g + R_1 + R_s = R_t$ and let $L_d + L_s = L$. E(s) is the Laplace transform of the time domain driving voltage plus the initial conditions in the circuit. The impedance seen by E(s) is $Z(s) = S^2LC + S(R_tC - Lg_d) + (1 - R_tg_d)/SC - g_d$. If the circuit is stable when driven by a voltage source, Z(s) must be a short circuit stable impedance. This means that the numerator polynomial, now defined as q(s), of Z(s) must have no zeroes in the right half of the S plane or on the imaginary axis. That is, the roots of the numerator polynomial must have negative real parts. Let us examine this statement further. Suppose that the roots are real and have the form of $S = S_1$ and $S = S_2$, where S_1 and S_2 are positive real numbers. If this were so, then q(s) would be $S^2 + S(S_1 + S_2) + S_1S_2$. Now suppose that the roots are $S = -A + jB$ and $S = -A - jB$, a conjugate pair of complex roots with negative real parts. The polynomial would then be $S^2 + 2AS + A^2 + B^2$. Notice that in both cases the coefficients of the polynomials are positive and that no terms are missing. The statement may now be made that a necessary but not sufficient condition for stability is that the coefficients of q(s) be positive. It is also necessary to have all the powers of S present. The requirement may be stated that $LC > O$, $R_tC - Lg_d > O$, and $1 - R_tg_d > O$. From the third of these conditions, $R_tg_d < 1$ so that $R_t < 1/g_d$. This was also observed previously as a result of the tri-stable load line. From the second condition, $R_tC > Lg_d$ so that $R_t > Lg_d/C$. These two restrictions on R_t may be combined into the single inequality, $Lg_d/C < R_t < 1/g_d$. Consider now if these necessary conditions are also sufficient. The numerator polynomial is Hurwitz, so the Routh-Hurwitz criterion for stability may be applied. The Routh-Hurwitz array for q(s) appears below.

$$\begin{array}{ccc} LC_d & 1-R_tg_d & O \\ R_tC_d-Lg_d & O & O \\ 1-R_tg_d & O & O \\ O & O & O \end{array}$$

The terms in column 1 must all be positive if the necessary and sufficient conditions for stability are to be satisfied. However, this restriction yields the previous result, $Lg_d/C < R_t < 1/g_d$, so the condition is both necessary and sufficient for stability.

It is not the purpose of this report to discuss oscillators in detail, but several details are worth mentioning. These topics are related to the preceding discussion of stability.

One of two types of instability may occur, depending on whether or not R_t is larger or smaller than it is supposed to be. This point can be clarified by examining the roots of q(s). The two roots are given by the expression, $S = -1/2(R_t/L - g_d/C) \pm \sqrt{1/4(R_t/L - g_d/C)^2 - (1 - R_tg_d/LC)}$. If R_t is not less than R_d then $\sqrt{1/4(R_t/L - g_d/C)^2 - (1 - R_tg_d/LC)}$ will be real and greater than $1/2(R_t/L - g_d/C)$. This means that there will be one zero on the positive real axis of the S plane, and so, the circuit response will be a simple increasing exponential. On the other hand, if $Lg_d/C < R_t$ is violated a pair of complex zeroes will exist on the imaginary axis or in the right half of the S plane. In the latter case, nonlinearity of the negative conductance region will limit the amplitude of the resulting exponentially increasing oscillations, so in both cases, sustained oscillation will take place and in the latter case distortion of the wave form will be in evidence. The literature refers to the latter class of oscillations as relaxation oscillation. The departure from distorted sinusoidal oscillation to relaxation oscillation is gradual so it is safe to use the common convention of referring to both types as relaxation oscillation.

--Continued on page 18

LOOK AHEAD: LOOK SOUTH — Continued from page 6

Another interesting Southern-designed car is the wood chip car. Used to haul huge cargoes of wood chips to pulp and paper mills, two of these cars will carry the same quantity of wood chips as five 70-ton hopper cars. The large capacity and easy side-unloading permit attractive rates and plant cost reduction for shippers -- a savings passed on to the consumer!

Southern recently announced entry into the growing trailer-on-flatcar business. Naturally, another familiar freight vehicle that will appear with greater frequency in Southern trains is the popular "Piggy-Back" type car. Southern also has facilities for the latest variation of this business, the handling of large containers only -- without highway wheels or underframe. These cars are complemented also by a new-type tri-level automobile carrier, having a total capacity of 12 standard-sized automobiles or 15 of compact size.

Word might be mentioned here too of the many Southern Railway freight cars regularly engaged in carriage of "over-sized" shipments, i.e., bulky shipments which because of their awkward physical characteristics cannot be carried conveniently without special handling and attention. In transporting these valuable cargoes, engineers must be sure that the shipment will not be damaged either by overhead obstructions such as bridges, power lines, etc., or by collision with objects near the sides of a moving train.

Southern Railway's interest in machine accounting extends back to the turn of the century when the Hollerith punched card machine was developed at the Census Bureau in Washington and was first used for business operations by the Railway. In later years, Southern also pioneered in developing railroad applications for the IBM 650 Computer, and in 1956 installed the nation's first IBM 705 Model II.

International Business Machines Corporation has announced that Southern Railway is "the first railroad and one of the first companies in any industry to order this newest and most powerful business computer," the newly developed, transistorized, IBM 7080 data processing system.

Electronic data processing has become so important to Southern that the present large scale computer, the IBM 705 Model II, is running at capacity around the clock. The 7080 will provide up to ten times greater speed and capacity, both of which will be helpful in producing reports and more sophisticated accounting, including business problem simulations.

The 7080 will be installed in the impressive Southern Railway Computer Center at Atlanta, Ga., where it will be supplemented by two of IBM's new 1401 data processing systems. In addition, a 1401 system will be installed in the Company's downtown Washington office building for corporate accounting, disbursements, and general management reporting. Both 1401 systems, over 600 miles apart, will be compatible through exchange of tapes.

As a note of interest to engineering students, just a word about young engineers on the Railway. Southern has long been a pioneer in the inauguration of formal selection and training programs for young engineers. It is the desire of the Company to assure that there always will be a qualified "man behind the man" who now holds any responsible management job. From these programs, the first of which was started in the Operating Department (engineering) in 1912, have come most of today's officer personnel on the Railway. In addition five presidents and many other high-ranking officers of other railroads were Southern-trained through these programs.

And so, the Southern is beginning to realize the full benefits of this vast modernization it has undergone recently. With a greatly improved physical plant, it is giving shippers and passengers a new high standard of personalized, tailored service -- thus helping to meet the competitive challenge of other types of transport.

As the combined efforts of some 30,000 men and women, these achievements provide a moving example of American private enterprise at work -- for a better railroad system, a better South, and in turn a better nation, through creative railway engineering.

CAMPUS NEWS

The annual Engineer's Ball will be held Saturday May 13, 1961 at The Charterhouse Motel. There will be four hours of dancing to the music in a contemporary style by the five piece combo of Tony Matarrese beginning at 10 p.m. The Charterhouse Motel is located at the corner of Shirley Highway and Edsall Road. Tickets can be purchased from members of the Engineer's Council at $5.00 per couple. Activities Awards, Mecheleciv Keys, Engineer's Council Keys, Deacon Ames Activities Award, and Professional Society Awards will be presented. One of the highlights of the dance is the crowning of next year's Queen of the Engineering School, who was selected from the six Mech Misses which have appeared in THE MECHELECIV during this year.

The revised Honors List of the School of Engineering appears below. The students whose names appear below have met all requirements established by the Faculty for this recognition of meritorious scholastic achievement.

HONORS LIST

FALL SEMESTER 1960-61

Alonso, Carlos A.	Kaminetzky, Lee
Calarco, John R.	Klisch, Francis M.
Eddins, Donald L.	McIntosh, Thomas E.
Flatt, Harvey J.	Miller, Donald A.
Gillilland, Kitt E.	Perazich, William
Golab, Thomas J.	Treynor, Paul E.
Hill, Howard T.	Wilkinson, Herbert S.

The officers of the ASCE for the coming year are: Howard Hill, President; Wes Harris, Vice-President; Tom Nielson, Secretary; Paul Oscar, Treasurer. The election of the officers of the ASME for next year will be held at the next monthly meeting.

The IRE-AIEE officers, who were elected at the last meeting, are: John Wolfgang, Chairman; Marvin Fox, Vice-Chairman; Judy Popowsky, Secretary; Walter Santilli, Treasurer; Edward Stennett, IRE Secretary; Edward Levitt, AIEE Secretary; Robert Kopsides and Bob Bruce, Mecheleciv Rep.; Andrejs Jaunrubenis, WRGW.

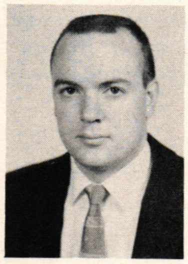
The newly elected officers to the Engineer's Council for the coming year, 1961-62, are: Joe Sandford and John Wolfgang, Senior Representatives; Don Miller and Lee Kaminetzky, Junior Rep.; Richard Singer, Sophomore Rep.; Floyd Mathews, Theta Tau; Randy Kenyon, Sigma Tau; Deane Parker, AIEE; Harvey Flatt, IRE.

Mr. Rochelle of NASA spoke on Telemetry Systems at the monthly meeting of the student chapter of the AIEE-IRE, which was held on May 3.

The Mecheleciv extends congratulations to Tom Golab, Kitt Gilliland, and Herb Wilkinson, who were awarded Cooperative Graduate Fellowships from the National Science Foundation.

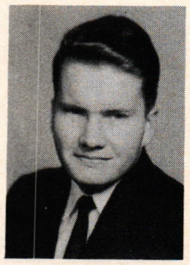
Three E.E. Students Receive Awards

The following students have been awarded the Cooperative Graduate Fellowships from the National Science Foundation. On behalf of the student body, the faculty and administration we wish to extend our congratulations on your outstanding scholastic achievement.



Thomas J. Golab was born in Ford City, Pa. in 1933. His family moved to Washington shortly after. He attended high school at Gonzaga and at Maryland Park, graduating from the latter in 1951. He entered George Washington in 1957 on a cooperative program with the Navy for whom he had worked after leaving high school.

Tom has been married for three of his four long years at George Washington and has a two year old son. Tom is a member of The Engineer's Council, Sigma Tau and Sigma Epsilon. He hopes to do graduate work in the field of computers and specialize in computers after he leaves school.



Herbert S. Wilkinson was born right here in Washington in 1939 where he has lived since. Herb graduated from Montgomery Blair High School as President of the Class of 1957. He received the Texaco Scholarship from George Washington University, and as a result of this financial aid he will receive his B. E. E. Degree this June. He has served as a representative on the Engineer's Council for the past four years, and this year is President of the Engineers Council. He is president of Sigma Epsilon Honor Society (A local society petitioning Tau Beta Pi for a national charter).

While attending George Washington Herb has received the following honors: Alumni Award for the Outstanding Senior E. E., Who's Who in Americal Colleges and Universities, Omicron Delta Kappa, Sigma Tau Engineering Honor Fraternity, Theta Tau Engineering Professional Fraternity, Sigma Epsilon Honor Fraternity and AIEE-IRE Student Branch. Herb spends his summers working for Diamond Ordnance Fuze Laboratory as a student trainee in electronics. Next year he will study for the M.S.E. degree with the N.S.F. Cooperative Fellowship.

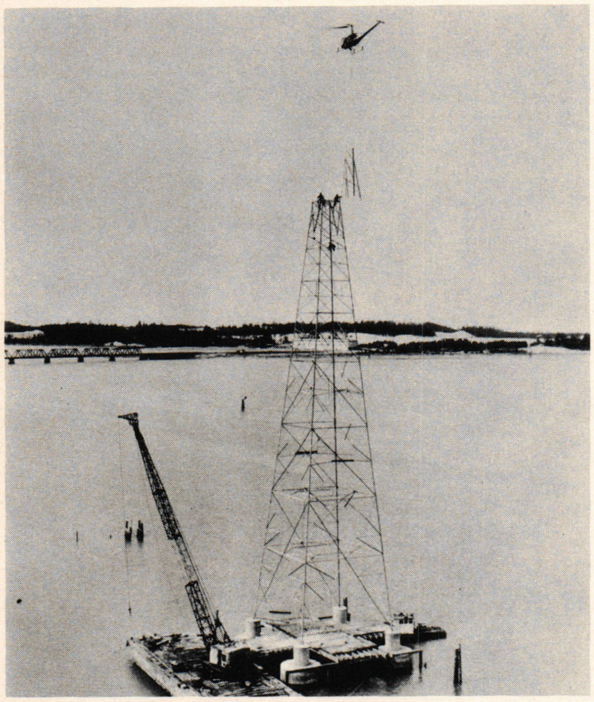
Kitt E. Gillilland was born in Washington, D.C. in 1939 and has lived here since that time. he graduated from Western High School in 1957. Kitt's activities in high school included: President, Phi Beta Rho (a scholastic honorary society), Assistant Manager of Stage Crew, Student Council representative, intramural football, High school Cadets, Rifle Club.

At George Washington Kitt has received the following honors: Secretary-Treasurer, Sigma Epsilon, Secretary, Sigma Phi Epsilon, Theta Tau, Sigma Tau, Sigma Pi Sigma (a physics honor society), Associate member, IRE-AIEE Student Branch and Engineering Director of WRGW Radio Workshop. Kitt has received the following college awards: Association of Federal Communications Consulting Engineers Scholarship, 1958-1961 and the National Science Foundation Cooperative Graduate Fellowship for the academic year 1961-1962.

Bureau of Standards, who, upon reviewing the text, decided that all parts would benefit from revision. Many changes were made in the text, including the recommendation that the more reproducible temperature of freezing zinc (419.505°C) be used in place of the boiling point of sulfur (444.600°C) as a defining fixed point. However, it was thought that action at this time would be premature, so the sulfur point remains one of the six defining fixed points of the International Practical Temperature Scale.

The revised text was adopted by the 11th General Conference on Weights and Measures, meeting in Paris in October 1960. It includes the substitution of the triple point for the ice point as one of the defining points of the scale. Thus, the triple point, 0.01°C or 273.16°K, becomes the one point where the practical and thermodynamic scales exactly coincide.

FIRST STEEL TOWER BUILT BY LIGHT HELICOPTER TOPPED OUT FOUR DAYS AHEAD OF SCHEDULE



1,700-lb sky hook, *dwarfed by crane and tower, kept as many as four riggers busy bolting assemblies in place. 305 hp Hiller 12E made more than 30 trips to complete upper 93 feet of 200-ft tower in slightly more than four hours. Conventional gin pole method would have taken five days for same section. Pacific Power and Light line spans 1,200-foot wide ocean shipping channel in Coos Bay, Ore.*

A 200-foot tall steel transmission tower was topped out four days ahead of schedule recently when a Hiller 12E light utility helicopter airlifted 93 feet of the structure in half ton steel sections to within arms reach of riggers.

The entire project, from the 111-foot level until the last insulator was bolted in place, took only 4-1/2 hours of flying time by the 305 horsepower Hiller, which itself weighs only 1,700 pounds.

According to officials of Pacific Power and Light Company, Tyee Construction Co., and Columbia Helicopters, it was the first time a light helicopter had been used to erect a heavy steel structure and the first time an airlift had been used over water in the Pacific Northwest.

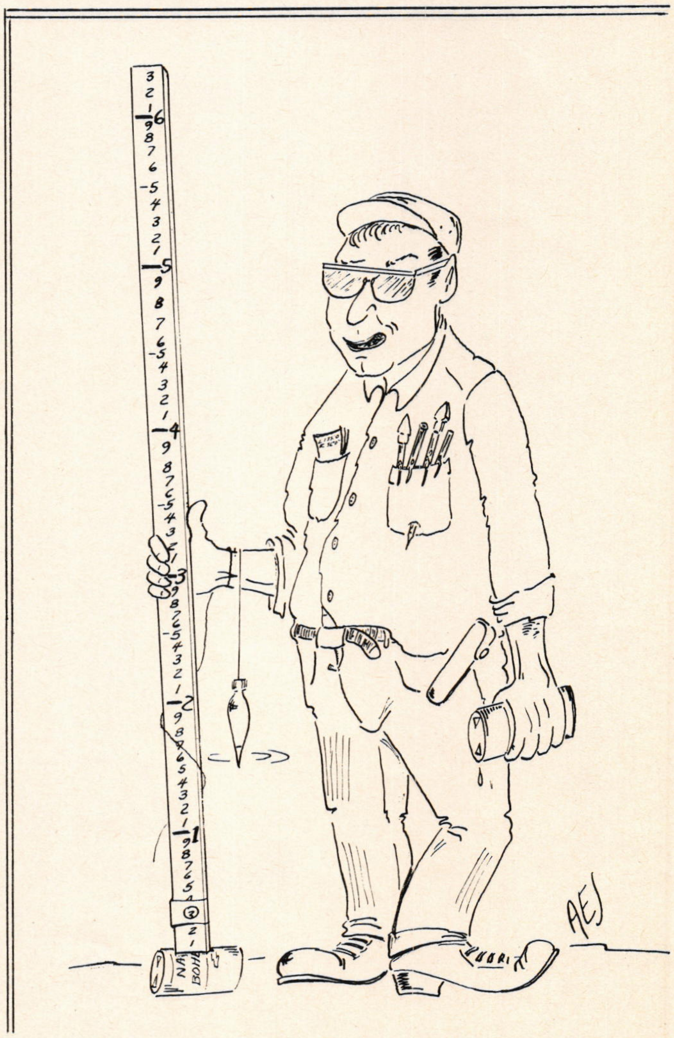
After a barge-mounted crane had erected the lower 111 feet of the tower on concrete footings, the remaining pre-built sections, ranging in weight from 500 to 1,200 pounds, were laid out in order of assembly on the nearby shore about 1,000 yards from the tower.

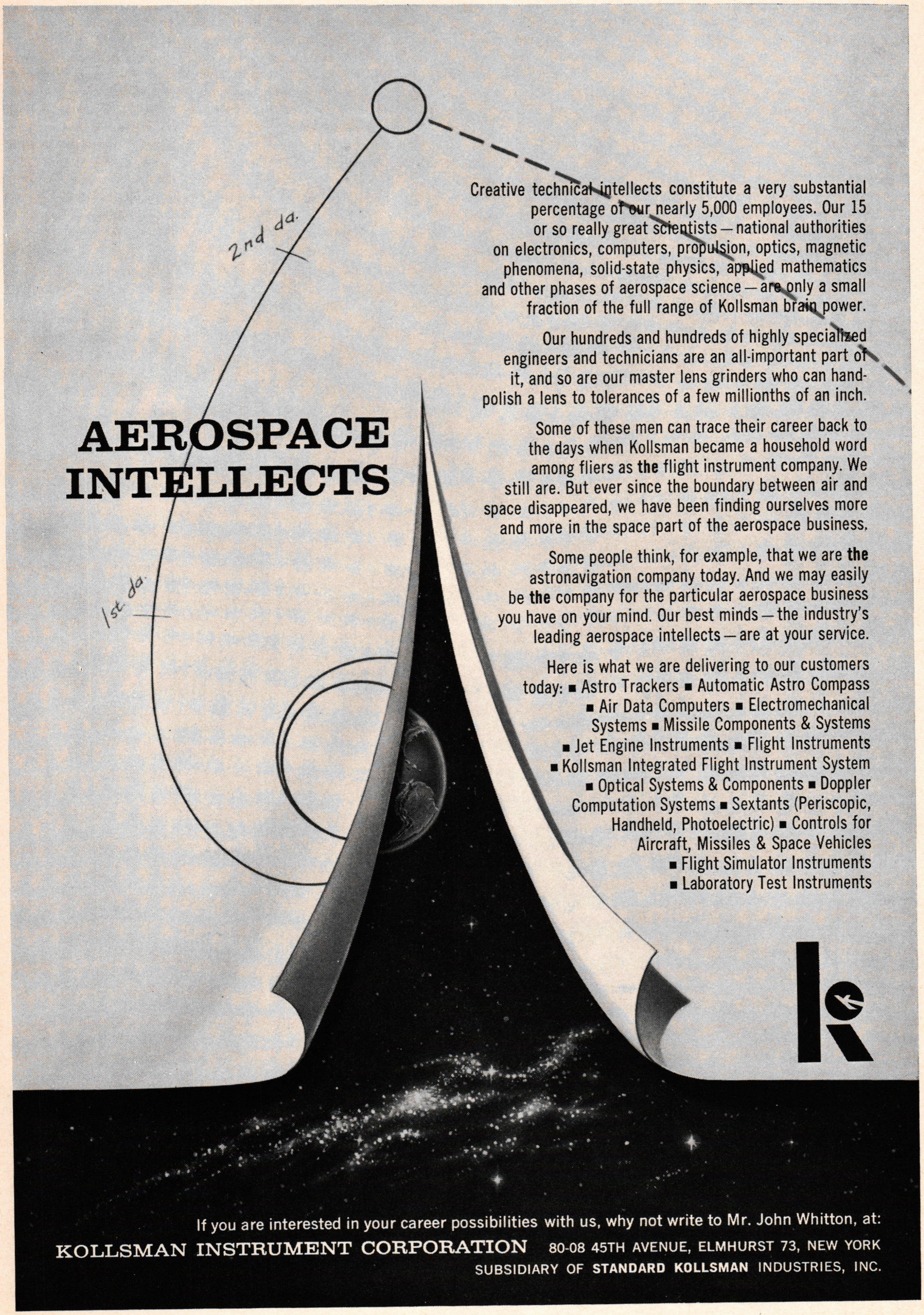
As pilot Wes Lamatta, head of the helicopter charter contract firm, hovered over the staging area, the ground team hooked each steel section to the Hiller's cargo hook. Above the tower, Lamatta hovered steadily with each steel section as the riggers' arm signaled him into position. Once the assembly was bolted in place he pressed the electrically controlled cargo hook release and flew back for another load.

Average time for each delivery round trip was under five minutes. Thirty structural assemblies plus insulators were delivered in this way in some four hours flight time. Conventional gin pole practice would have required five days, according to construction and Pacific Power and Light officials.

Lamatta's firm, which operates Lycoming powered Hillers on heavy construction projects throughout the Northwest, finished the second tower across the channel the following week and has other power line jobs scheduled soon in mountainous country in Washington.

Hiller 12E series helicopters are built in Palo Alto, California by Hiller Aircraft Corp., a subsidiary of Electric Autolite Co.





2nd da.
1st da.
AEROSPACE INTELLECTS
Creative technical intellects constitute a very substantial percentage of our nearly 5,000 employees. Our 15 or so really great scientists—national authorities on electronics, computers, propulsion, optics, magnetic phenomena, solid-state physics, applied mathematics and other phases of aerospace science—are only a small fraction of the full range of Kollsman brain power.
Our hundreds and hundreds of highly specialized engineers and technicians are an all-important part of it, and so are our master lens grinders who can hand-polish a lens to tolerances of a few millionths of an inch.
Some of these men can trace their career back to the days when Kollsman became a household word among fliers as **the** flight instrument company. We still are. But ever since the boundary between air and space disappeared, we have been finding ourselves more and more in the space part of the aerospace business.
Some people think, for example, that we are **the** astronavigation company today. And we may easily be **the** company for the particular aerospace business you have on your mind. Our best minds—the industry's leading aerospace intellects—are at your service.
Here is what we are delivering to our customers today: ■ Astro Trackers ■ Automatic Astro Compass ■ Air Data Computers ■ Electromechanical Systems ■ Missile Components & Systems ■ Jet Engine Instruments ■ Flight Instruments ■ Kollsman Integrated Flight Instrument System ■ Optical Systems & Components ■ Doppler Computation Systems ■ Sextants (Periscopic, Handheld, Photoelectric) ■ Controls for Aircraft, Missiles & Space Vehicles ■ Flight Simulator Instruments ■ Laboratory Test Instruments
If you are interested in your career possibilities with us, why not write to Mr. John Whitton, at:
KOLLSMAN INSTRUMENT CORPORATION 80-08 45TH AVENUE, ELMHURST 73, NEW YORK
SUBSIDIARY OF STANDARD KOLLSMAN INDUSTRIES, INC.

The condition, $R_t < Lg_d/C$, was derived from the inequality $R_t/L - g_d/C > 0$. It was mentioned that violation of this condition resulted in a conjugate pair of oscillatory zeroes. The border line situation, where the zeros fall upon the imaginary axis, is brought about when $R_t/L - g_d/C = 0$.

When this situation exists, $S = \pm\sqrt{-(1-R_t g_d/LC)}$ and the frequency of oscillation, $\overline{F}$, will be given by the expression, $F = 1/2\pi\sqrt{1-R_t g_d/LC}$.

Now that the more straightforward aspects of stability have been considered, let us examine a more subtle source of instability. Between the input and output terminals of an amplifier there will be a certain amount of stray capacity. This capacity may be due to lead dress, the tunnel diode socket, or the capacity which is an integral part of any non-ideal resistor. This capacity might exist in the manner shown by the following circuit:

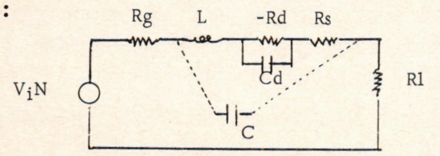


FIGURE 5

Using the previously presented notation, $R_t = R_g + R_1$, we may redraw the circuit (see figure 7). The new circuit appears below.

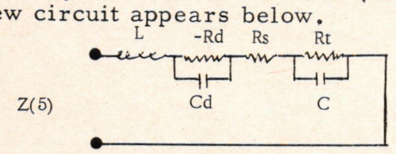


FIGURE 6

As before, $Z(s)$ must be a short circuit stable impedance. $Z(s) = q(s)/P(s)$ and $q(s) = S^3(LR_tR_dCC_d) + S^2(R_sR_tR_dCC_d + LR_dC_d - LR_tC) + S(R_sR_dC_d + R_tR_dC_d + R_tR_dC - L - R_tR_sC) + R_d - R_t - R_s$. As was previously demonstrated, if $q(s)$ represents a stable impedance, all of the coefficients of the polynomial must be positive. Applying this proposition to $R_d - R_t - R_s$ immediately reaffirms the criterion that $R_t < 1/g_d$. The Routh-Hurwitz array of $q(s)$ or $q(s)$ itself will yield more information about the stability of $Z(s)$. Recalling that the coefficients of $q(s)$ must be positive, we may say that $R_sR_tR_dCC_d + LR_dC_d - LR_tC > 0$. Now operations can be done on this expression to obtain a restriction on the magnitude of C, the stray shunt capacity. $C(R_sR_tR_dC_d - LR_t) + LR_dC_d > 0$ and $C(R_sR_tR_dC_d - LR_t) > -LR_dC_d$. Finally, $C < LR_dC_d / LR_t - R_sR_tR_dC_d$. Now substitute typical numerical values into this expression. A General Electric 1N2939 tunnel diode has the following parameters:

$L_d = 6 \times 10^{-9}$hy $\qquad R_d = 100$ ohms

$C_d = 7 \times 10^{-12}$pf $\qquad R_s = 1$ ohm

A typical value of R_t might be 90 ohms. Therefore, $C < 7 \times 10^{-12} \times 10^2 \times 6 \times 10^{-9} / 6 \times 10^{-9} \times 9 \times 10 - 9 \times 10^3 \times 7 \times 10^{-12}$ or $C < 8.8$pf. This condition is necessary but not sufficient. Indeed, substitution of this value into the Routh-Hurwitz array causes the term in the third row of the first column to become $-\infty$. It would appear that one must exercise care in choosing the physical layout of a tunnel diode amplifier if instability is to be avoided. Indeed, a stray capacity of only 8.8pf is sufficient to cause oscillation if one uses a 1N2939.

Now that the stability criteria have been examined, look at the circuit in terms of sinusoidal phasor representation. This approach will allow the operation of the amplifier circuit to be understood without quite as much algebra present to obscure the details. First consider a parallel combination of resistance and capacitance.

Separating the real and imaginary parts of $Z(jw)$, we get the following expression:

$$Z(jw) = R/1 + W^2R^2C^2 - j\,WR^2C/1 + W^2R^2C^2.$$

For positive values of W, it can be seen that $Z(jw)$ lies in the fourth quadrant of the $Z(jW)$ plane. One might postulate that the locus of $Z(jW)$, as w varies, is some type of circular locus. Let us test this hypothesis. When w is zero, $Z(jw) = R$ and when $w - \infty$ $Z(jw) = 0$. Thus the locus might be of the form shown below.

W = Greek omega

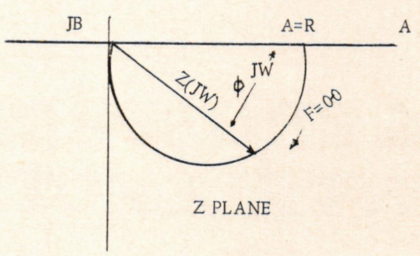


FIGURE 7

That is, the locus might be a circle of radius $1/2R$ and center $A = 1/2R$. The equation of such a circle in terms of the coordinates A and B is given by $(A - 1/2R)^2 + B^2 = (1/2R)^2$, where $A = R/1 + W^2R^2C^2$ and $B = -WR^2C/1 + W^2R^2C^2$. If the locus is indeed a circle, then $A^2 - AR + (1/2R)^2 + B^2 = (1/2R)^2$ or $AR - A^2 = B^2$. Substituting the values of a and B into the above we see that we obtain an identity. That is,

$$\frac{R^2}{1 + W^2R^2C^2} - \left(\frac{R}{1 + W^2R^2C^2}\right)^2 = \left(\frac{WR^2C}{1 + W^2R^2C^2}\right)^2$$

so the hypothesis is verified. Similarly, the locus of $Z(jw)$ of a parallel combination of $-R$ and C is also a circle. Suppose that a parallel R and C were connected in series with an inductance. Further, suppose that a sinusoidal unit reference current existed in this circuit. The voltage drop, E, across this circuit would be the vector sum of the impedance phasors of the parallel R and C and of the series inductance. This is shown below. A voltage phasor equal to $-E$ would be required to drive the circuit and produce the unit

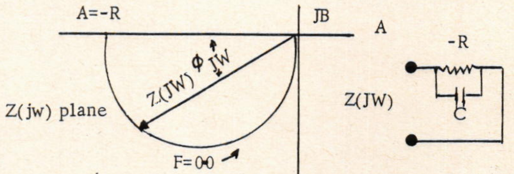


FIGURE 8

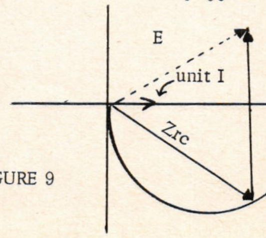
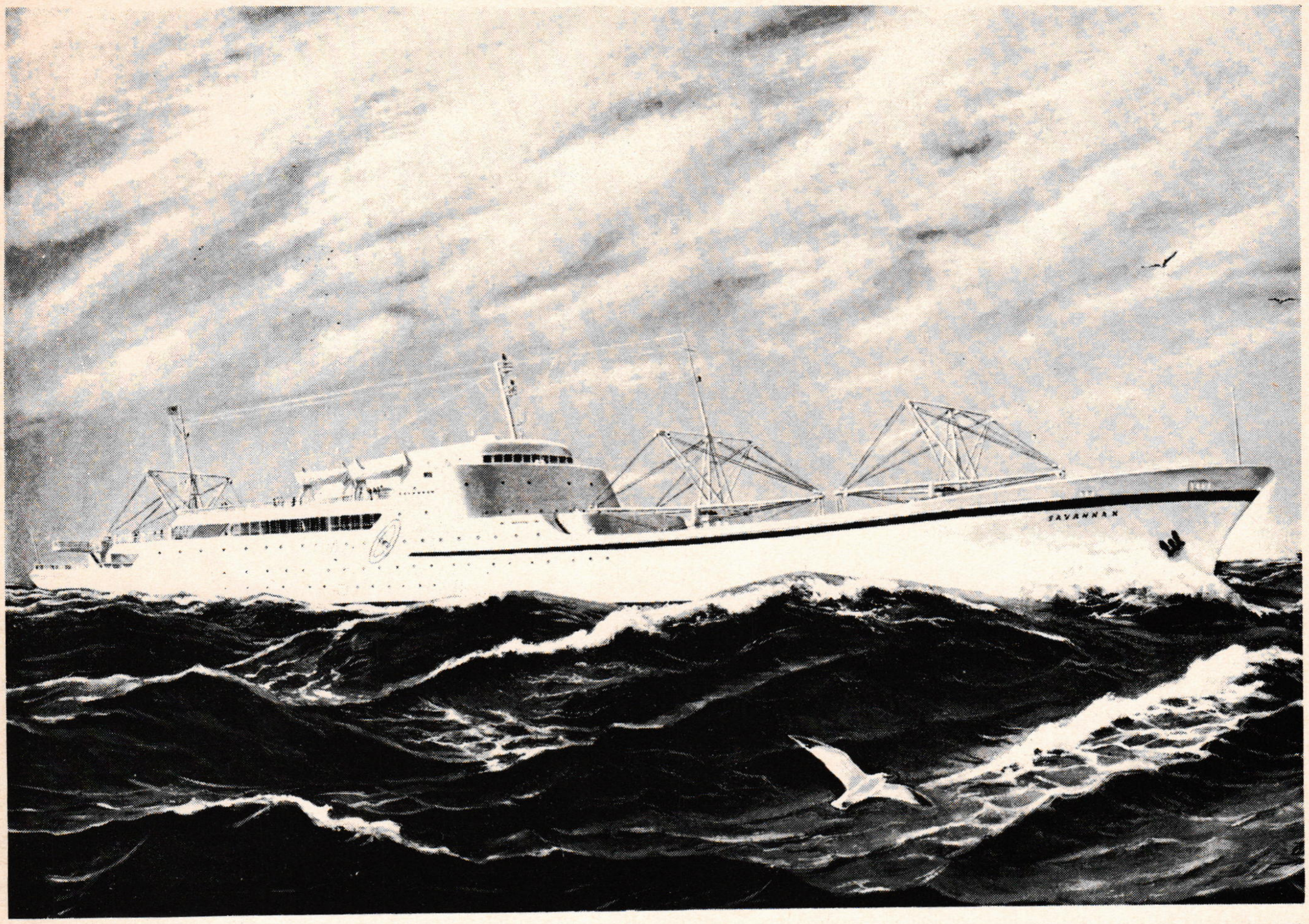


FIGURE 9

--Continued on page 22



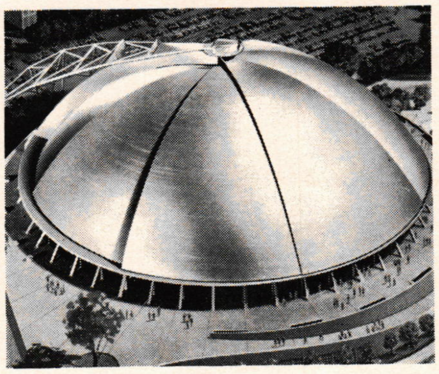
The Nuclear Ship Savannah is capable of sailing 350,000 nautical miles without refueling. Her uranium oxide fuel is packaged in tubes of Nickel Stainless Steel, more than 5,000 of them. In all, engineers specified 200,000 pounds of Nickel Stainless Steel for use in the ship's reactor... to meet the demands of high operating pressures and temperatures, and to provide much-needed strength and corrosion resistance in this critical application.

How Inco Nickel helps engineers make new designs possible and practical

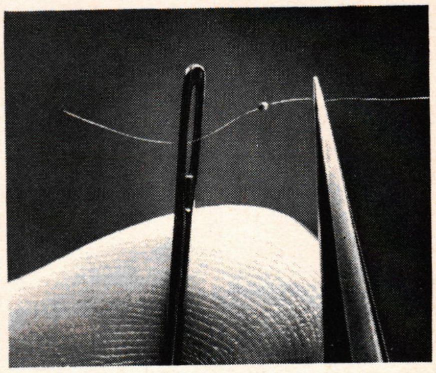
When you design equipment, you'll have to select materials to meet given service conditions – materials that might have to resist corrosion, wear, high temperatures, or fatigue. Over the years, Inco has developed new alloys and gathered information on the performance of materials under these and many other service conditions. Inco will be glad to put this data at your disposal to help solve your future metal problems.

Inco's List "A" contains descriptions of 200 Inco publications which are available to you, covering applications and properties of Nickel and its alloys. For List "A", write Educational Services.

The International Nickel Company, Inc.
New York 5, N. Y.



New push-button roof of Nickel Stainless Steel turns a weatherproof auditorium into an open-air stadium in a matter of seconds. The dome will provide years of carefree beauty. That's because stainless steel with Nickel in it is one of the most durable of metals. It's corrosion-resisting all the way through.



Needle's eye reveals relative size of a Thermistor, a tiny bead made with Nickel oxide—used to measure temperatures in and beyond the earth's atmosphere. The Nickel oxide helps develop electrical properties for the accurate recording of temperature changes as small as 1/50th of a degree!

INCO **INTERNATIONAL NICKEL**

The International Nickel Company, Inc., is the U.S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) —producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium, Sulfur and Platinum, Palladium and Other Precious Metals.

TECH NEWS

Edited by Jim Jennings

COHERENT LIGHT?

The research laboratories of Hughes Aircraft Company, of Southern California, have recently announced the development of a source of "coherent" light. The "laser" (Light Amplification by Stimulated Emission of Radiation) is a solid state device that amplifies and generates coherent energy in the optical, or light region of the electromagnetic spectrum.

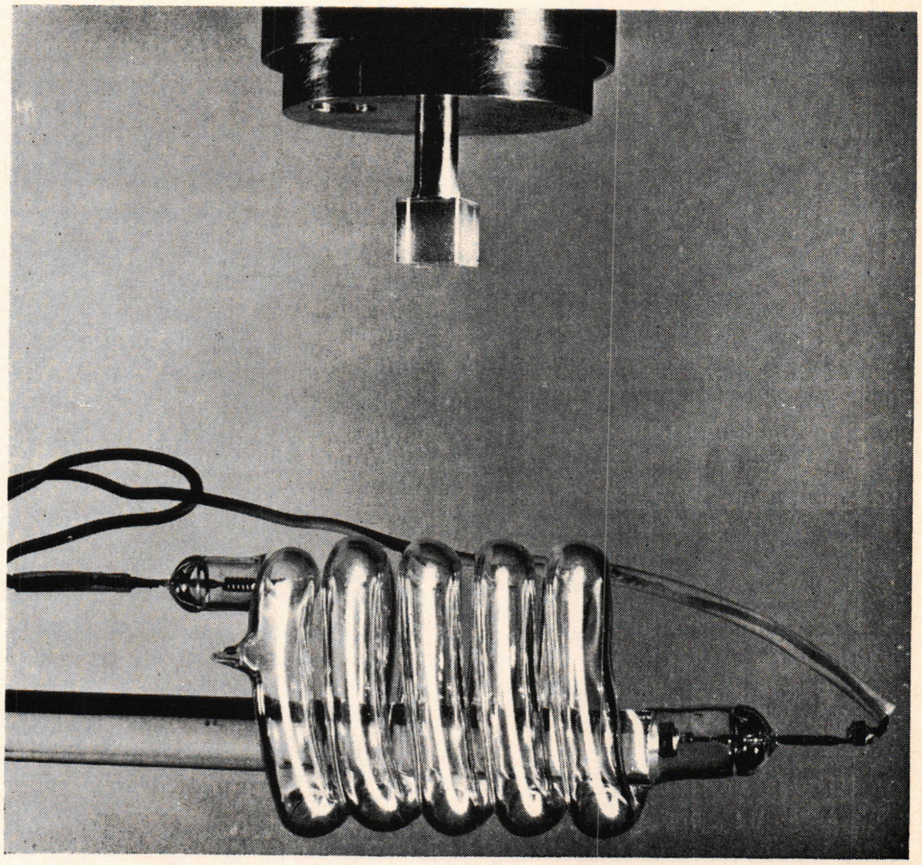
The electromagnetic spectrum, broadly speaking, includes radio waves, which start with commercial radio at one million cycles per second and extend into the upper microwave region of fifty thousand million cycles per second. Progressively higher frequencies include infrared or heat waves, light, ultraviolet, X-rays, gamma rays, and finally cosmic rays.

Throughout the entire radio spectrum it has been possible to generate energy of *almost* one definite, or single frequency. The smaller this band of frequency in which radiation is generated, the more "coherent" the source is said to be. The advantages of a coherent source are many and it has long been desired to extend the coherent spectrum into higher frequency ranges. The laser represents the results of a research program in the optical spectral region. Instead of jumping the gap in the spectrum by a factor of five as has been done in the past fifteen years, the laser represents a jump by a factor of ten thousand from previously attainable coherent sources. This device radiates energy at a frequency of five hundred thousand billion cycles per second.

In brief, the operation of the laser is as follows:

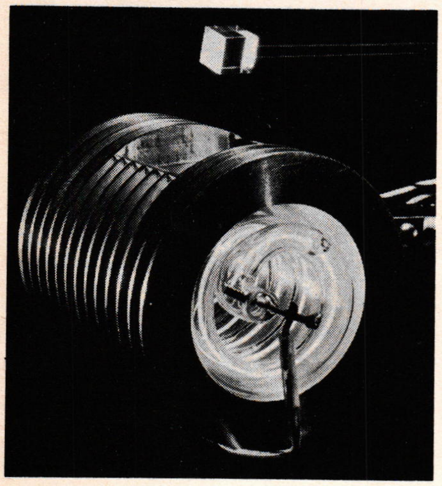
1. A light source, in the form of a powerful flash tube lamp, irradiates a synthetic ruby crystal which absorbs energy over a broad band of frequencies.
2. This optical energy excites the atoms to a higher energy state from which the energy is reradiated in a very narrow band of frequencies.
3. The excited atoms are coupled to an optical resonator and stimulated to emit the radiation together. This is in contrast to ordinary light sources where the atoms radiate individually at random and the randomness is responsible for the incoherence of these latter sources.

As a direct consequence of its coherence the laser is a source of very high "effective" or equivalent temperature, higher than that encountered at the center of the sun. The term "equivalent" is used because this is not the actual temperature of the laser but rather the temperature to which an ordinary light source would have to be heated to generate a monochromatic signal as bright as the laser's



(several billion degrees). Actually, the laser is not a hot source, but is a "cool" source in the ordinary sense of the word and therefore does not burn up.

The color of light is a manifestation of its frequency, and the purity of a color is determined by the width of the emitted spectrum. Because light waves, in principle, could be produced a million times more monochromatic, or single hued, as those from a mercury or neon lamp, lasers could generate the purest colors known.



Glowing with absorbed light (top) is a synthetic ruby crystal, heart of the laser. The light source (below) excites the atoms of the crystal which then reradiates energy in an intense parallel beam.

Another important property of the laser, indirectly a consequence of its coherence, is that it radiates an almost perfectly parallel beam. It could in principle, generate a beam less than a hundredth of a degree of arc width, which when reaching the moon, nearly a quarter million miles away, would illuminate an area less than 10 miles wide. By contrast, if an ordinary searchlight could reach the moon, its beam would spread over 25,000 miles and its brightness would, of course, be correspondingly reduced. This follows from the fact that the searchlight is a finite-sized incoherent source. As another example, the laser beam if sent from New York to Columbus, Ohio would only spread 100 feet, while the searchlight beam would spread 50 miles.

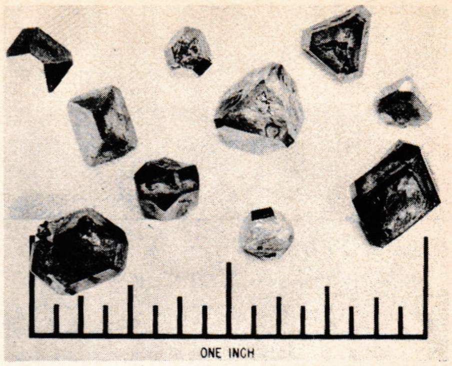
The laser's use in radar and communications for space work is obvious, since there is no atmosphere in space to absorb or scatter the beams. It could be used in effect as a light radar. The small beam spreading would give rise to extremely high resolution. A beam directed at the earth from a satallite 1000 miles up would be concentrated into an area about 200 feet wide.

The minimum spot size that a coherent energy beam can be focused into is approximately equal to the wave length of the radiant energy. The laser emits energy in the extremely high frequencies of optics where the wave length is between 15 and 30 millionths of an inch (for comparison, the wavelength for commercial radio is about 300 yards; 60 cps house current has a wavelength of 3000 miles). Therefore, laser beams, in principle, could be concentrated to a pinpoint size of a few ten millionths of an inch diameter. When energy is concentrated in such small areas its intensity is very great and the beam therefore could generate intense local heat. This suggests the possibility of many uses such as sterilizing surfaces with the focused beam. Individual parts of bacteria, small plants and particles could be vaporized. Surface areas might be modified and chemical or metallurgical changes could be induced. It is also possible that this device will show the way to enormous increases in the present number of available communications channels.

The Hughes research was conducted under the direction of Dr. Theodore H. Maiman, who was also responsible for developing the "ruby-maser" amplifier, a 25 pound superdetector "electronic-ear" for the U. S. Army Signal Corps' research and development laboratories.

Tree Crusher

A huge new tree-crushing machine can clear scrub forest land at the rate of three acres an hour. The 47½-ton, diesel-electric machine pushes trees to the ground and smashes them into splinters with heavy, blade-studded rollers. The vegetation becomes a compressed mat that can be burned in place.



A group of carat-sized diamonds made by scientists (seen against a one inch scale).

MAN-MADE DIAMONDS

General Electric has recently announced the development of large, man-made diamonds. These diamonds (over a carat in size) are dark in color and, because of structural imperfections, are not yet of sufficient mechanical strength for industrial use.

These large stones are the result of high-temperature, high-pressure research programs which were responsible for the production of the world's first man-made diamonds in 1955. At present the largest diamonds suitable for use in industry are about one-tenth of a carat, but these are not yet in commercial production.

Uncertain conditions in diamond supplying countries (Congo) make the production of man-made diamonds of strategic importance.

A REPORT ON TUNNEL DIODE AMPLIFIERS — Continued from page 18

current I. If the unit current existed in a parallel combination of -R and C, depending on the values of R and C, the voltage drop across the circuit could equal -E. This means that if all of the aforementioned elements were connected in series the unit current I would exist with no driving source in the loop! The combination of -R and C would take the place of the driving source. Under this condition, the circuit would be a sinusoidal oscillator! If the phasor diagram did not quite close at any frequency, then the circuit would be an amplifier. This situation is shown below.

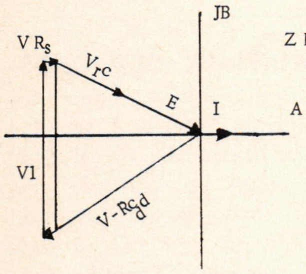


FIGURE 10

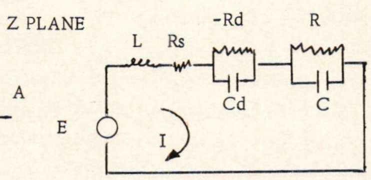
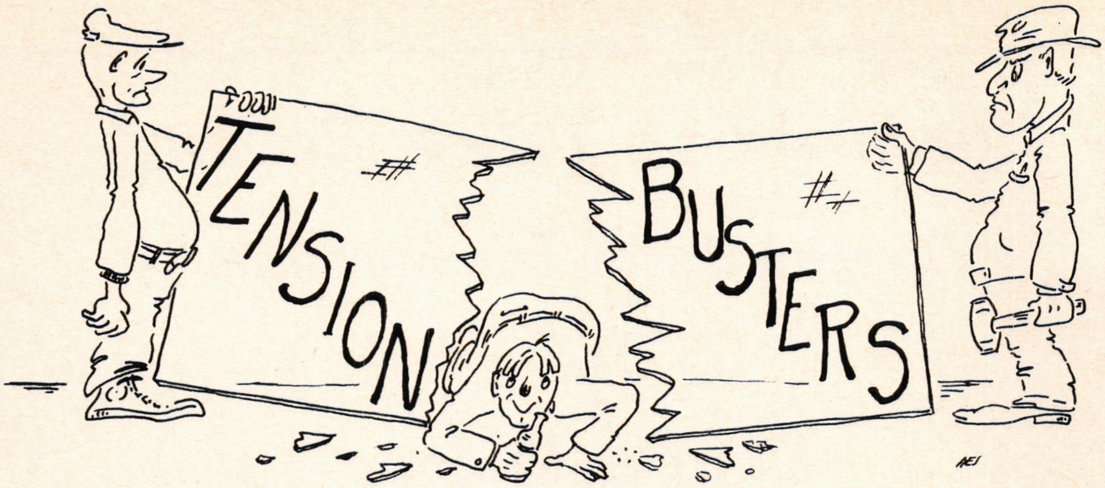


FIGURE 11

It is evident that E produces voltages larger than itself in the circuit. Any of the larger voltages could be considered to be the output of the circuit and the circuit would be an amplifier. Provided that no stability criteria were violated, one could change one of the parameters of the system slightly and quickly deduce what effect the change would produce. The change would appear as a change of length and/or angle of one of the phasors.

CONCLUSION

The tunnel diode has been shown to be a device which may amplify a voltage which varies about some bias point in the negative conductance region. It was also demonstrated that aside from the small parasitic capacitance and inductance in the device the tunnel diode responded to such excitation as though it were a negative resistance, though to D.C. voltage it was a nonlinear positive resistance. The Laplace variable, s, was used to examine two cases of stability and the fundamental relationship $Lg_d/C < R_d < R_t$ was obtained. In a working circuit, using a GE 1N2939 tunnel diode, a gain of 36 DBV at 6 mc over a 3 DB bandwidth in the order of 1 mc. As a final word of caution, it should be recognized that a device which is active at frequencies in the kilomegacycle region must be used in a circuit which minimizes stray capacity, and that instrumentation must combine high input impedance with high sensitivity and high frequency response. The tunnel diode has proven to be quite suitable for high frequency amplification provided that these precautions are observed. The phasor technique allows the device to be manipulated in a readily determined prescribed manner.



Several girls complained to the dean of women that the boys in the fraternity house next door never closed their blinds and that it embarassed the girls. When the dean went to the room of the particular girl who had made the complaint, she looked out the window and said, "Why, I can't see in their window from here."

The firl said, "Oh, you have to stand on the chair."

A lumberjack on an early spring trip wandered unknowingly into the maple syrup district of Vermont. Taking a stroll into the woods one day he noted a lot of buckets hanging on the trees. "Gosh a'-mighty," he exclaimed in astonishment, "they sure have sanitary dogs in these parts."

Three gentlemen appeared at the railroad station, alcoholically propelled. As they reached the platform, the train began to move, and all three staggered for it. The station cop and a porter managed to bundle two of them aboard -- one on the last car -- but by this time it was going too fast for the third gent. He stood sadly on the platform watching the train disappear.

"Too bad, mister," the cop said, "Wish you could have gone aboard?"

"Yes," replied the man, "and my frens'll be sorry too. They were seeing me off."

Fellow to blind date: "I never really believed in reincarnation -- but what were you before you died?"

Engineer on telephone: "Doctor come quickly! My little boy just swallowed my slide rule."

Doctor: "Good heavens, man, I'll be right over. What are you doing in the meantime?"

Engineer: "Using log tables."

Voice on phone: "Are you the desk clerk?"

Desk Clerk: "Yes, what's eating you?"

Voice: "That's what I'd like to know."

Two WACs were returning late one night and got into the wrong barracks -- the enlisted men's. One lost her head and ran; the other remained calm and collected.

Respectfully stolen by
Larry Irwin

Visitor in Harem to the Sultan: "I'll have a short one just to keep you company."

Mother: "Well, son, what have you been doing all day!"

Son: "Shooting craps, mother."

Mother: "That must stop. Those little things have as much right to live as you."

At a baseball game a young lady asked her escort, "Why does the man behind the hitter wear such a large bib?" He explained to her that it was to keep the catcher's shirt from getting mussed when the ball knocked his teeth out.

A tourist walked into a bar in South Africa and was startled to see a customer in full uniform yet only six inches high. "Evidently you don't know the major." The tourist admitted this so the bartender picked the little man from the stool, put him on the bar and continued: "Speak up, Major; tell the Yank about the time you called the witch doctor a bloody fake."

Introducing the new deacon to her deaf father a young girl said: "Father, this is the new deacon."

"New dealer," exclaimed the father with surprise.

'No, no. Not a dealer; a new deacon. He's the son of a bishop."

The father nodded wisely, "They all are."

Then there is the sad story of the EE who went nuts trying to hook up a Laplace transformer.

Through the smoke and ozone
fumes the student slowly rises;
His hair is singed, his face is
black, his partner he despises:
He shakes his head and says to
him, with words so softly
spoken,
"The last thing you said to me
was, 'Sure, the switch is open.'"

The kiddies were being taken on a tour of the mint.

"Why is it," asked one of them, "that they stamp 'In God We Trust' on the pennies?"

"That," explained the guide, "is for the benefit of people who use them for fuses."

An Eng. major, taking his first ride on a bus, lit up a cigarette as he sat reading the advertisements overhead.

Finally the driver came along, tapped him on the shoulder, and said, "Whatso matter, can't you read, buddy? That sign up there says NO SMOKING!"

"Yeah," said the Engr. "But the one next to it says, wear Playtex Girdles, so I ain't paying any attention to either of 'em."

Little girls count on their fingers; big girls count on their legs.

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.*

GENERAL ELECTRIC